Mars Reconnaissance Orbiter Project Overview

Presentation at the AO Bidder's Conference

June 15, 2001

Jim Graf

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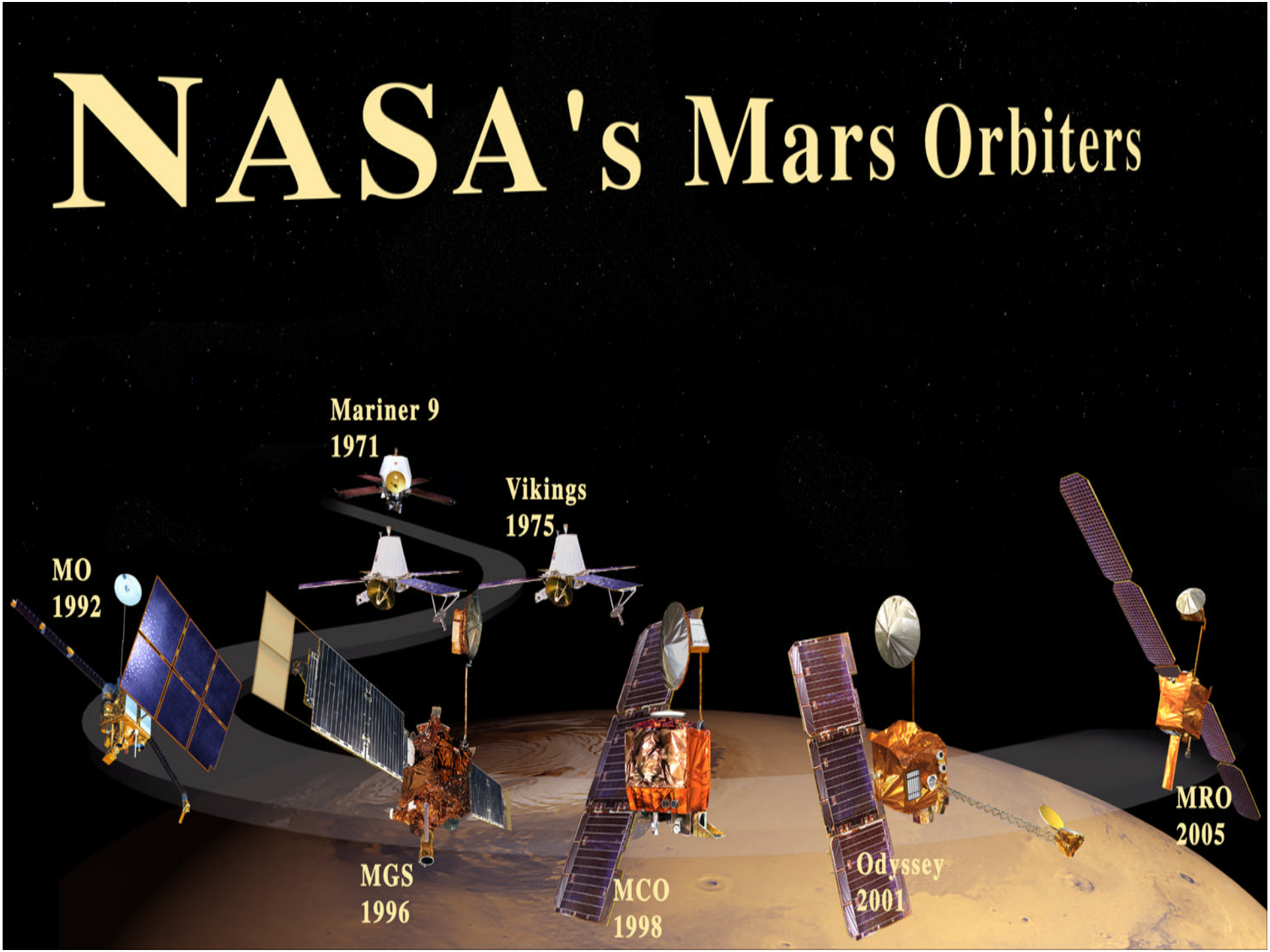
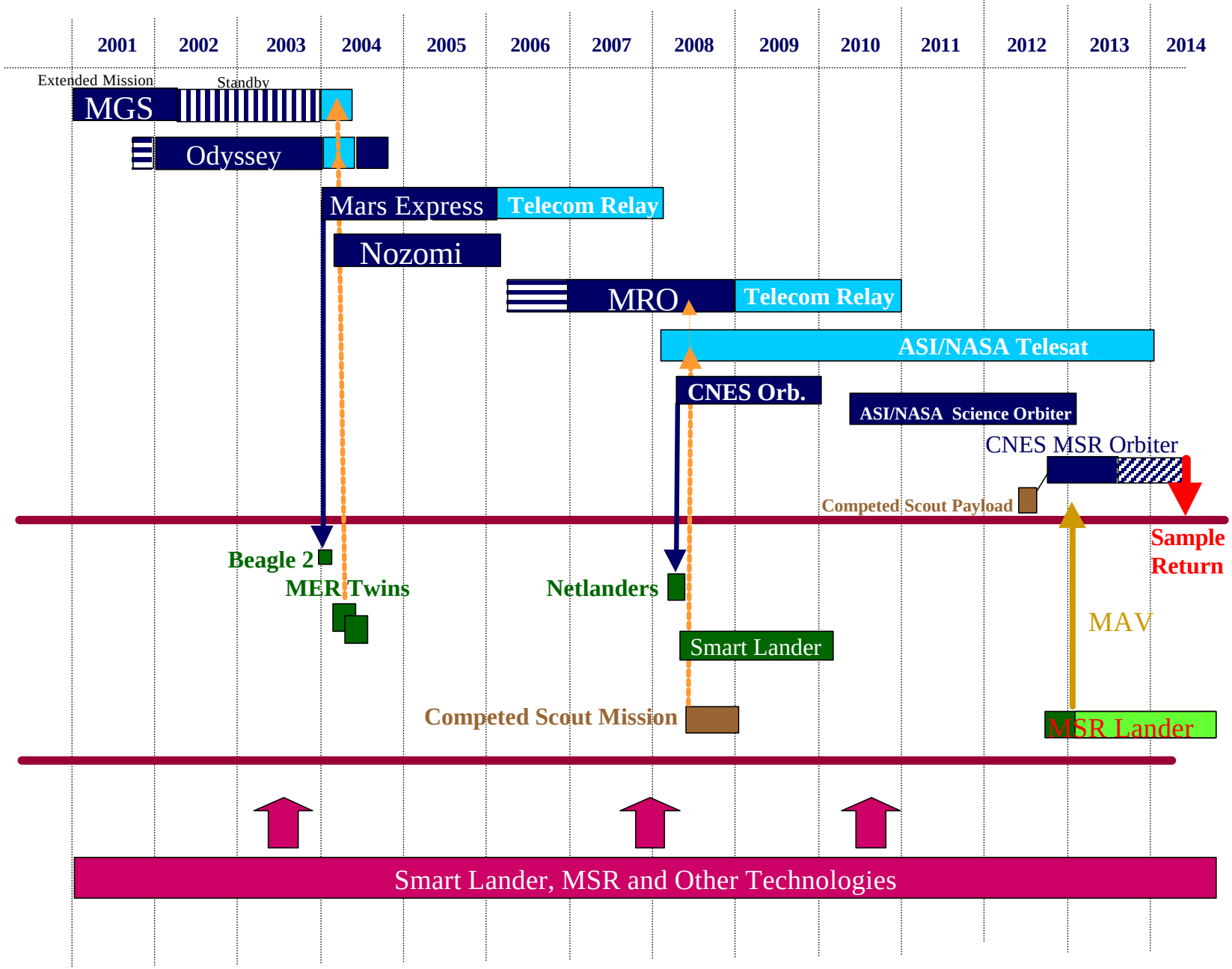

NASA's Mars Orbiters
Mariner 9
1971
Vikings
1975
MO
1992
MGS
1996
MCO
1998
Odyssey
2001
MRO
2005

MARS EXPLORATION PROGRAM

Mars Mission Timeline



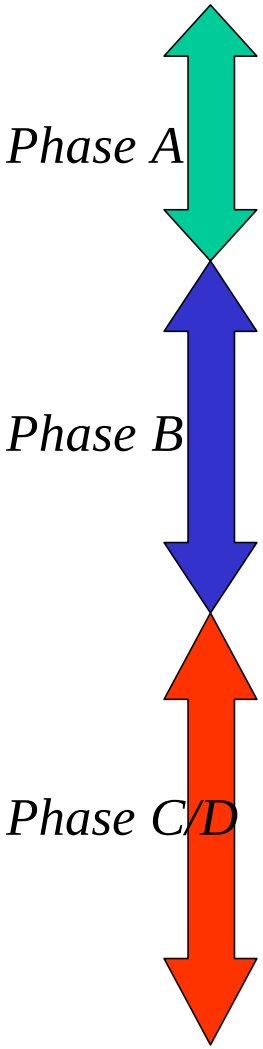
Summary of Project Objectives

- Launch, in the ‘05 opportunity, a science-oriented orbiter to Mars which enables the recovery of the MCO science objectives and additional high-priority science objectives defined by the AO process.
- Conduct remote sensing science observations for one Martian year (~2 Earth years).
- Conduct site characterization for future potential landers.
- Provide an UHF telecom relay capability for follow-on missions for an additional Martian year after completion of the primary science phase.

Procurement Strategy

- Major elements of the project being competed to industry/academia.
  - This AO competes several major instruments and solicits facility teams for other investigations.
  - Launch services competed via the NLS contract. The launcher will be intermediate class (i.e., Delta 3 or 4 or Atlas 3 or 5).
  - Orbiter design and development is covered by an RFP to industry.

Major Instrument Milestones



System Requirements / Capabilities Review (SR/CR)	11/15/01
Preliminary Mission System Review (PMSR)	1/25/02
Initial Confirmation Review (ICR)	2/1/02
Instrument Accommodation Review (IAR)	3/1/02
Instrument PDRs Complete	6/4/02
Project / Orbiter PDR	7/31/02
Confirmation Review (CR)	8/14/02
Instrument CDRs Complete	12/10/02
Project / Orbiter CDR	4/21/03
Science Engineering Models Delivered	9/2/03
Science Flight Models Delivered	4/1/04
Launch	8/5/05

Near Term Instrument Schedule

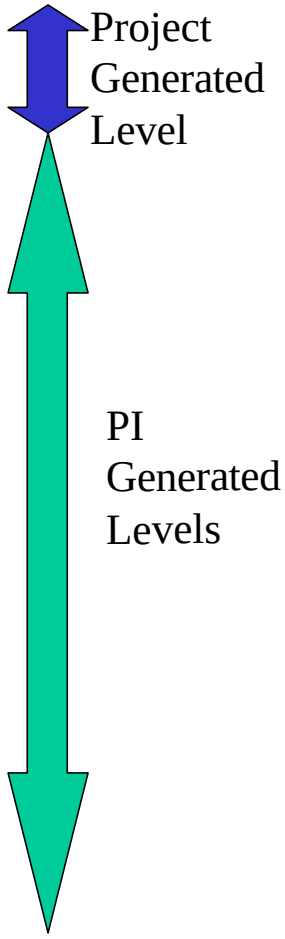
Milestone	Date
• Instrument Selection	November 2001
• Kickoff Meeting @Inst. Industrial Contractor	November 2001
• Interface Meeting @Orbiter Contractor	December 2001
• Project Science Group Meeting @JPL	December 2001
• Preliminary Mission and System Review@JPL	January 2001
• Initial Confirmation Review @HQ	February 2001

Mission Operations Description

- Geographically distributed including instrument teams, Orbiter contractor, JPL, DSN stations.
- Instrument Team responsibilities:
  - Instrument command request generation and validation.
  - Instrument health and welfare monitoring and analysis via S/C engineering and instrument telemetry.
  - Science data products generation, distribution, and delivery to archive center.
- Project responsibilities:
  - Instrument data distribution.
  - Command requests integration and validation.
  - Binary command generation, radiation, and receipt verification.
  - Navigation.
- Orbiter contractor responsibilities:
  - Orbiter engineering command request generation and validation.
  - Orbiter and instruments health and welfare monitoring and analysis via S/C engineering.

MEP Data Levels/Generation Plan

NASA	CODMAC	Description
Packet data	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level 0	Edited - Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1-A	Calibrated - Level 3	Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied.)
Level 1-B	Resampled - Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 1-C	Derived - Level 5	Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.



Mars Reconnaissance Orbiter AO / PIP Briefing

Reference Mission Description

M. D. (Dan) Johnston

June 15, 2001

Primary Science Orbit

- Primary Science Orbit (selected by the MRO Science Definition Team)
  - 3:00 pm LMST (local mean solar time) Sun-synchronous orientation
    - 3:00 pm LMST orientation will be established at the ascending node of the orbit
      - Variation of the true sun about the mean sun is approximately 45 minutes
    - Near polar orbit (Sun-synchronous)
  - Low altitude “elliptical” orbit
    - Minimum periapsis altitude of 200 km, average apoapsis altitude near 400 km

Launch/Arrival Strategy

- Launch Strategy
  - Intermediate-class expendable launch vehicle
  - Reference Launch Period: August 8, 2005 - August 28, 2005
    - Twenty-one day launch period

- Interplanetary Cruise
  - 7-month transit to Mars (Type 1 ballistic trajectory)

- Arrival Period Strategy
  - Arrival nodal geometry compatible with aerobraking strategies
    - Arrive with a proper nodal orientation with respect to the Sun
  - Initial Capture Orbit Period: 35 hours (nominal)
  - Reference Arrival Period: March 3, 2006 - March 11, 2006

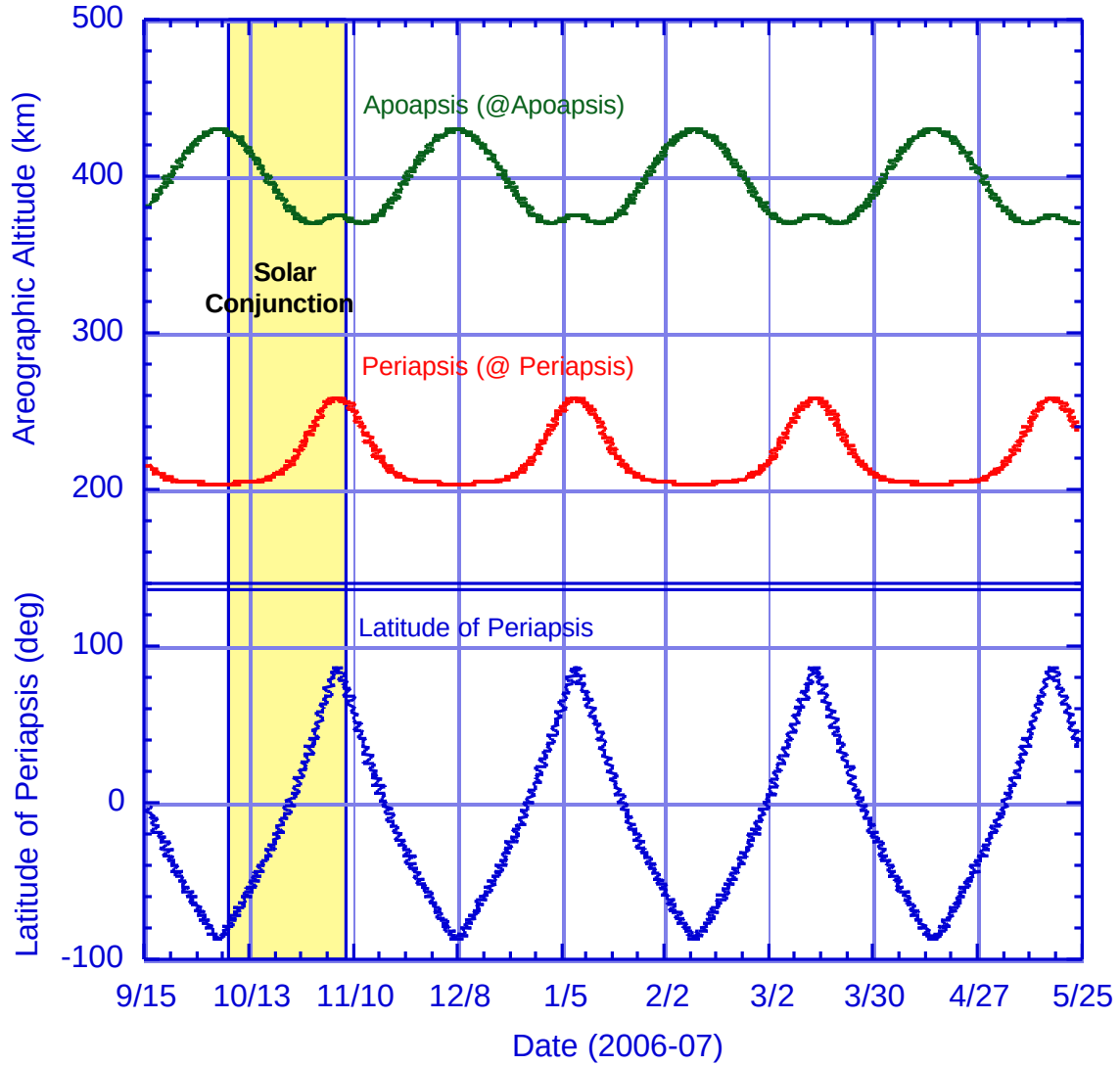
Aerobraking to the Primary Science Orbit

- Aerobraking techniques will be used to establish the Primary Science Orbit
  - Aerobraking is a time-constrained activity
    - Complete the necessary orbit period reduction by the time the ascending node of the orbit reaches proper alignment with respect to the Sun [3:00 P.M. LMST (local mean solar time) orientation]
  - Allocated a duration of six months for the completion of aerobraking
    - Maintain appropriate spacecraft margins while aerobraking

      => Balance spacecraft limitations versus mission risk

- Science instrument data collection will begin when the Primary Science Orbit is established
  - Establish the PSO no later than Sep 23, 2006 (2 weeks prior to the start of solar conjunction)
    - Solar conjunction: Oct 7, 2006 - Nov 8, 2006 (SEM Angle < 5 deg)

Primary Science Orbit Characteristics



Science Data Acquisition and Return

- Science Data Acquisition
  - Hybrid mission conducting global mapping, regional surveys, and targeted surface observations
    - Climate Mapping (Re-flight of the MCO Investigations):
      - PMIRR Mk II, MARCI
    - Targeted Observations:
      - High resolution imager (HRI), Visible/near infrared spectrometer (VIS/NIR), Shallow sub-surface radar
  - To acquire data, the science instruments will be nadir-oriented
    - To enhance surface observation capability, the spacecraft will have the ability to point cross-track up to 30 deg from nadir

- Science Data Return
  - Orbiter telecom system will be capable of 280 kbps for maximum Earth-Mars range (2.67 AU)
    - Daily data returned during two 8-hour DSN passes
      - ~10 Gbit data returned per day at long range
      - Shorter ranges could allow up to 100 Gbit per day

Relay Operations and End of Mission

- Relay Operations
  - Perform telecommunications relay and navigation support for follow-on missions launched in 2007 and/or 2009
  - Science operations may continue as an extended mission (if approved)

- End of Mission (End of CY 2010)
  - Satisfy planetary quarantine requirements
    - Boost the orbit altitude up to ~430 km near-circular orbit

Mars Reconnaissance Orbiter
Orbiter Overview

Howard J. Eisen
MRO Flight System Manager

15 June 2001

Orbiter Procurement

MRO will be built by an industrial partner, selected via a RFP process

- Final RFP released 04/27/2001
- Multiple proposals received 06/13/2001
  - The membership of the Source Evaluation Board and Technical Evaluation Committees (TEC) will not be made public.
  - The TEC includes MRO science and payload representation
  - Those involved in Orbiter proposal evaluation are forbidden from participating in payload proposals.
- Award expected in September, 2001
  - No more information will be released until that time
- Phase A will include the evolution of many of the Orbiter Level 2 and 3 requirements.
- Phase A/B will include the development of Orbiter-Payload ICD's

Reference Payload Accommodations

- Volume: No explicit limitations
  - Orbiter proposers were given for reference
    - HRI: Optics: Ø 0.6m x1.5 m high, Electronics: 0.24 x 0.24 x 0.06 m
    - VisNIR: Optics: 0.7 x0.3 x 0.3 m, Electronics: 0.3 x 0.3 x 0.15, Scan Mirror Drive: 0.13 x 0.13 x 0.03 m
- Mass: 63 kg CBE allocated
  - No explicit breakdown between HRI and VisNIR
  - SDT-suggested target of 40/23 kg split; no one instrument takes all
- Data:
  - 1 ea. up to 20 Mbps LVDS high-speed serial interface per payload
  - 9600 bps RS-422 interfaces also available
  - 2 ea. 5V TTL discretes
  - 4 ea. Analog temperature sensors
  - 36 Gb total science data storage
- Command:
  - 2 ea. 5V TTL programmable discretes (same as above)
  - 500 kbps RS-422
  - 2 MB command/sequence storage
  - 10 MB NVM for payload code
- Power: 82 W operating/survival orbital average, 26 W cruise survival
  - No explicit breakdown between HRI and Vis/NIR
  - One power, one heater switch per instrument

Major Payload Deliverables

- Hardware Development Deliverables
  - Fit Check Template
  - Payload Interface Simulator
  - Engineering Model and Ground Support Equipment
- Software Development Deliverables
  - Analytical Thermal and Structural Models
  - Initial Software
  - Telemetry Calibration Data
  - Preliminary Sequences
- Flight Deliverables
  - Flight Hardware and Ground Support Equipment
  - Flight Software
  - Flight Sequences
  - Flight Rules/Constraints
- All deliverables must be accompanied by the appropriate documentation package.